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池养条件下的负选择对凡纳滨对虾
种质退化的影响

Effect of Negative Selection under Pond-rearing Conditions
on Germplasm Degradation of Shrimp
Litopenaeus vannamei

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摘要

凡纳滨对虾(*Litopenaeus vannamei*)是我国对虾养殖最重要经济种类。本研究综合应用实验生态学、形态学、海水养殖学及生物化学等多学科的方法和技术,探讨了在相同养殖环境条件下原种亲虾和池养亲虾在生殖生产性能及其卵子和无节幼体质量的差异;研究了第一代和第二代的无节幼体在育苗实验过程生产性能、生化组分、形态、行为及抗应激能力的差异;查明一代虾苗和二代虾苗养殖的生产性能和经济效益。以期为对虾养殖业的健康、安全、高品质和可持续发展提供理论指导,并为甲壳动物生殖生态学和遗传育种学的研究积累基础资料。主要结果如下:

1、原种亲虾和池养亲虾的生殖性能及其卵子质量和无节幼体质量

以亲虾形态学参数、生殖性能参数及组织生化组分作为指标对凡纳滨对虾原种亲虾(对照组)和池养亲虾(实验组)进行研究。结果如下:(1)性腺指数对照组显著高于实验组($P<0.01$);体况指数、肝胰腺指数也是对照组高于实验组但无差异($P>0.05$)。

(2)在促熟期间,对照组的存活率均高于实验组,差异明显($P<0.05$)。日均成熟率、日均交配率对照组均高于实验组,且走势随促熟天数的增加均呈上升趋势,达极值后稍有下降。相对产卵量和无节幼体产量对照组均明显高于实验组($P<0.01$);呈现逐日增长趋势,并各有一峰值;当天产卵虾比例和受精率均保持在99%以上,对照组与实验组之间差异不明显($P>0.05$);孵化率对照组明显高于实验组($P<0.01$)。(3)在卵巢,蛋白质、葡萄糖及甘油三酯含量对照组均高于实验组,总胆固醇含量对照组与实验组之间差异不明显($P>0.05$)。在肝胰腺蛋白质含量、葡萄糖含量及甘油三酯含量对照组均极明显低于实验组($P<0.01$),而总胆固醇含量前者明显高于后者($P<0.05$)。(4)卵径对照组明显高于实验组($P<0.01$),而无节幼体体长对照组与实验组之间无差异($P>0.05$)。在卵子,蛋白质、葡萄糖、甘油三酯及总胆固醇含量对照组均高于实验组,其中,蛋白质、葡萄糖含量差异极明显($P<0.01$),甘油三酯含量差异明显($P<0.05$),总胆固醇含量差异不明显($P>0.05$)。无节幼体的蛋白质含量、葡萄糖含量、甘油三酯含量及总胆固醇含量对照组均明显高于实验组($P<0.01$)。表明原种亲虾与池养亲虾在生殖生产性能上是存在比较明显的差异,前者表现出更好的优势;同时亲虾的不同来源对卵和无节幼体的质量也有较大影响。

2、第一代和第二代无节幼体质量的差异分析

以原种亲虾和池养亲虾繁育的第一代和第二代无节幼体作为材料,在水温30~

33 ℃，盐度 18~20，pH7.8~8.2 条件下，培育至第五期仔虾（PL₅），结果如下：（1）无节幼体的变态率和发育同步性、育苗存活率和单位水体出苗量等几项主要生产性能参数的指标，对照组均明显高于实验组（ $P<0.05$ ）；（2）在培育过程各期幼体蛋白质、葡萄糖、甘油三酯和总胆固醇的含量变化情况两组表现一致，且实对照组均高于实验组。（3）各期幼体的体长、体质量、生长速率、增重率和体长与体质量的相关关系等形态学参数指标对照组和实验组相比略有差异，但不明显（ $P>0.05$ ）；（4）幼体趋光性随着幼体的发育呈上升态势，从无节幼体发育至 PL₂ 达峰值，对照组明显高于实验组（ $P<0.01$ ）；幼体盐度剧减和剧增应激试验的存活率对照组明显高于实验组（ $P<0.01$ ）。表明池养亲虾在养殖过程受其养殖环境的影响是负选择的作用，严重地影响幼体的质量。

3、第一代和第二代虾苗养殖的生产性能和经济效益的差异比较

对一代和二代虾苗养殖的生产性能和经济效益进行调查分析，结果如下：（1）一代虾苗和二代虾苗放养的时间不同，前者集中在 9~10 月，后者集中在 4~5 月。在相同养殖模式下放苗密度相近时，二代虾苗养殖天数略长于一代虾苗（ $P>0.05$ ）。放养密度一代虾苗明显低于二代虾苗（ $P<0.01$ ）。生长速率，一代虾苗明显优于二代虾苗，土池养殖优于高位池养殖，但都没显著程度（ $P>0.05$ ）。养殖到商品虾的存活率一代虾苗为 58.19%，二代虾苗为 39.52%，相差 1.47 倍（ $P<0.01$ ）；高位池养殖模式为 62.15%，土池养殖模式为 35.54%，相差 1.75 倍（ $P<0.01$ ）。每亩单产一代虾苗（692.19 kg）高于二代虾苗（652.5 kg）但都没达显著程度（ $P>0.05$ ）；高位池养殖模式为 1200 kg，土池养殖模式为 144.69 kg。（2）养殖经济效益每亩盈利，一代虾苗为 5.335 万元，二代虾苗为 0.49 万元，相差 10.89 倍；若消除商品虾价格因素的影响，一代虾苗盈利 3.204 万元，是二代虾苗 6.538 倍。表明一代虾苗养殖的生产性能和养殖效果都比二代虾苗好。

关键词： 凡纳滨对虾；负选择；原种亲虾；池养亲虾；生殖性能；卵子质量；幼体质量

Abstract

Litopenaeus vannamei is the most important economic species in Chinese shrimp culture. This comparative study was conducted to investigate 1) the reproductive performance of original strain and that of pond-reared broodstocks, as well as the quality of egg and nauplius bred by them under same culture conditions and 2) the differences of production performance, the biochemical component, morphological and behavior characteristics, anti-stress ability between the first and second generation of nauplius, 3) the cultivation production performance and economic benefit of the first-generation shrimp seed and the second-generation ones by using the methods of experimental ecology, morphology, biochemistry and mariculture technology. The results would provide theoretical guidance to a healthy, safe and sustainable development of aquaculture industry, and basic data for the study of the reproductive ecology and genetic breeding of crustaceans in aquaculture. The main results and conclusions were as follows:

1. Reproductive performance and the quality of posterity -- egg and nauplius, of original strain and pond-reared broodstocks

The experimental subjects were original strain (control group) and cultured broodstocks (experimental group), BCI (body condition index), GSI (gonadosomatic index), HPI (Hepatosomatic index), reproductive performance parameters and tissue biochemical component were used as indicators in this study. The results were showed as follows: (1) GSI of control group was higher, very significantly ($P < 0.01$), than experimental groups, while there were no significant differences on BCI and HPI ($P > 0.05$); (2) During maturation-promoting, survival rates of the control groups were higher than that of experimental groups, significantly ($P < 0.05$). Daily maturing rate and daily mating rate of control groups were higher than that of treatment group, but no differences with the increase of maturation-promoting processing in the two groups, up to its peak and then declined. Relative fecundity and daily yield of nauplius in control groups were higher than that in treatment groups, very significantly ($P < 0.01$); both of them rose during maturation-promoting processing and reached a peak each; spawning rate and fertility rate were above 99% both in control groups and treatment groups, with non-significant differences ($P > 0.05$), but there was

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